

## Attachment J-C27.1

### Low Voltage Electrical Distribution Systems Work Instructions

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**SOW Item No. C27-01****LV Switchgear 5 Year PGM****Visual Inspection on Low Voltage Switchgear**

- \_\_1. Verify and record switchgear nameplate, equipment ID#, manufacturer, equipment type and model, and equipment year.
- \_\_2. Inspect physical condition including evidence of moisture or corona and required working clearances.

**Low-Voltage Air and Power Circuit Breaker****Visual and Mechanical Inspections**

- \_\_1. Inspect physical and mechanical condition.
- \_\_2. Inspect anchorage, alignment, and grounding.
- \_\_3. Clean the unit.
- \_\_4. Inspect arc chutes.
- \_\_5. Inspect moving and stationary contacts for condition, wear, and alignment.
- \_\_6. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- \_\_7. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer's published data.
- \_\_8. Verify cell fit and element alignment.
- \_\_9. Verify racking mechanism operation.
- \_\_10. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- \_\_11. Verify protective device trip settings are in accordance with trip settings provided by the Low Voltage Systems Manager.

**Electrical Tests**

- \_\_1. Perform resistance measurements through bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 in the ANSI/NETA MTS. Values of insulation resistance less than Table 100.1 in the ANSI/NETA MTS or manufacturer's recommendations should be investigated.
- \_\_3. Perform a contact/pole-resistance test. Microhm or dc millivolt drop values should not exceed the high levels of the normal range as indicated in the manufacturer's published

data. If manufacturer's data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

- \_\_\_4. Determine long-time pickup and delay by primary current injection. Long-time pickup values should be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band.
- \_\_\_5. Determine short-time pickup and delay by primary current injection. Short-time pickup values should be as specified, and the trip characteristic should not exceed manufacturer's published time-current tolerance band.
- \_\_\_6. Determine ground-fault pickup and delay by primary current injection. Ground fault pickup values should be as specified, and the trip characteristic should not exceed manufacturer's published time-current tolerance band.
- \_\_\_7. Determine instantaneous pickup current by primary current injection. Instantaneous pickup values should be within the tolerances of manufacturer's published data.
- \_\_\_8. Perform minimum pickup voltage test on shunt trip and close coils in accordance with Table 100.20 in the ANSI/NETA MTS. Minimum pickup voltage on shunt trip and close coils should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, refer to Table 100.20 in the ANSI/NETA MTS.
- \_\_\_9. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Auxiliary features should operate in accordance with manufacturer's published data.
- \_\_\_10. Reset all trip logs and indicators.
- \_\_\_11. Verify operation of charging mechanism. The charging mechanism should operate in accordance with manufacturer's published data.

## **Report**

- \_\_\_1. Fill out Low Voltage Breaker Maintenance Form.
- \_\_\_2. Identify deficiencies found in visual and mechanical inspections.
- \_\_\_3. Identify values of bolted electrical connections resistance measurement which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_\_4. Identify values of insulation resistance which are less than Table 100.1 in the ANSI/NETA MTS or the manufacturer's recommendation.
- \_\_\_5. Identify microhm or dc millivolt drop values of contact/pole-resistance which deviate from adjacent poles or similar breakers by more than 50% of the lowest value.
- \_\_\_6. Identify any other deficiencies found during electrical test where results are not in accordance with the manufacturer's published data.

## **Reference**

- \_\_\_1. Low Voltage Breaker Maintenance Form
- \_\_\_2. ANSI/NETA MTS Table 100.1
- \_\_\_3. ANSI/NETA MTS Table 100.20

## **Low-Voltage Molded-Case Circuit Breaker**

### **Visual and Mechanical Inspections**

- \_\_\_1. Inspect physical and mechanical condition.
- \_\_\_2. Clean the unit.
- \_\_\_3. Operate the circuit breaker to insure smooth operation. Verify that all circuit breaker contacts are open when the handle is in the OFF position and closed when the handle is in the ON position.
- \_\_\_4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12 in ANSI/NETA MTS.
- \_\_\_5. Verify protective device trip settings are in accordance with trip settings provided by the Low Voltage Systems Manager.

**Electrical Tests** (Note: Safely isolate the circuit breaker as installed. All electrical tests shall be performed with the circuit breaker in its equipment.)

- \_\_\_1. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole as described in NEMA AB 4. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 in the ANSI/NETA MTS. Values of insulation resistance less than Table 100.1 in the ANSI/NETA MTS or manufacturer's recommendations should be investigated.
- \_\_\_2. Perform a contact/pole-resistance test as described in NEMA AB 4. Microhm or dc millivolt drop values should not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
- \_\_\_3. Perform an inverse-time over current trip test as described in NEMA AB 4. This test is not applicable to instantaneous only breakers. The circuit breaker should trip within the maximum times shown in Table 3 in NEMA AB 4. Values of inverse-time trip test exceeding Table 3 in NEMA AB 4 should be investigated.
- \_\_\_4. Perform an instantaneous over current trip test as described in NEMA AB 4. Test result should be in accordance with the values shown in Table 4 in NEMA AB 4. Values of instantaneous over current trip test that are significantly different from the values in Table 4 in NEMA AB 4 should be investigated.
- \_\_\_5. Perform a rated hold-in test as described in NEMA AB 4 to verify the capability of a molded case circuit breaker to carry its rated current. The circuit breaker should not trip during the test. If it does trip, reset the breaker and turn it ON again. If the breaker continues to trip or if any of its terminals reach temperatures higher than 80 degree C, it should be investigated.

## Report

- \_\_\_1. Identify deficiencies found in visual and mechanical inspections.
- \_\_\_2. Identify values of insulation resistance which are less than Table 100.1 in the ANSI/NETA MTS or the manufacturer's recommendation.
- \_\_\_3. Identify microhm or dc millivolt drop values of contact/pole-resistance which deviate from adjacent poles or similar breakers by more than 50% of the lowest value.

- \_\_4. Identify values of inverse-time trip test exceeding Table 3 in NEMA AB 4.
- \_\_5. Identify values of instantaneous over current trip test that are significantly different from the values in Table 4 in NEMA AB 4.
- \_\_6. Identify breaker that continues to trip during a rated hold-in test or if any of its terminals reach temperatures higher than 80 degree C.

## **Reference**

- \_\_1. NEMA AB 4
- \_\_2. ANSI/NETA MTS Table 100.1
- \_\_3. ANSI/NETA MTS Table 100.12

**SOW Item No. C27-02**  
**LV Fuel Storage Area Grounding & Lightning Protection Semi-Annual PM**

**PM on Low Voltage Fuel Storage Area Grounding System**

**Visual and Mechanical Inspections**

- \_\_1. Verify ground system in compliance with ANSI/NFPA 70, National Electrical Code, Article 250.
- \_\_2. Inspect physical and mechanical condition.
- \_\_3. Inspect anchorage.
- \_\_4. Replace mechanical type connectors with exothermic type.

**Electrical Tests**

- \_\_1. Perform resistance measurements through bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_2. Perform fall-of-potential or alternative test in accordance with IEEE Standard 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground should be 5 ohms or less. Investigate if resistance values exceed 5 ohms.
- \_\_3. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived points. Investigate point-to-point resistance values which exceed 0.5 ohms.

**Report**

- \_\_1. Identify deficiencies found in visual and mechanical inspections.
- \_\_2. Identify values of bolted electrical connections resistance measurement which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_3. Identify fall-of-potential values between the main grounding and ground which exceed 5 ohms.
- \_\_4. Identify point-to-point resistance values between the main grounding system grounding system and all major electrical equipment frames, system neutral, and/or derived points which exceed 0.5 ohms.

**Reference**

- \_\_1. ANSI/NFPA 70, National Electrical Code, Article 250
- \_\_2. IEEE Standard 81

## **PM on Lightning Protection System (LPS) in Low Voltage Fuel Storage Area**

### **Visual and Mechanical Inspections to Ensure**

- \_\_1. The LPS is in good condition.
- \_\_2. There are no loose connections and no accidental breaks in the LPS conductors and joints.
- \_\_3. No part of the system has been weakened by corrosion, especially at ground level.
- \_\_4. All visually earth connections are intact.
- \_\_5. All visible conductors and system components are fastened to the mounting surfaces and components which provide mechanical protection, are intact and in the right place.
- \_\_6. There have not been any additions or alterations to the protected structure which would require additional protection.
- \_\_7. There has been no indication of damage to the LPS, surge protection devices, or any failures of fuses which protect the surge protection devices (SPDs).
- \_\_8. Bonding conductors and connections inside the structure are present and intact.

### **Electrical Tests**

- \_\_1. Perform continuity tests, especially continuity of those parts of the LPS which are not visible. Investigate those parts of the LPS that don't pass this test.
- \_\_2. Perform earth resistance tests of the earth-termination system. The resistance to earth each local earth electrode and where practical the resistance to earth of the complete earth-termination system. Each local earth electrode should be measured in isolation with the test joint between the down-conductor and earth electrode in the disconnected position. Investigate if the resistance to earth of the earth-termination system as a whole or of each local earth electrode exceeds 10 ohms.
- \_\_3. SPDs without a visual indicator need to be tested. Testing of SPDs should be in accordance with the manufacturer's published data.

### **Report**

- \_\_1. Identify deficiencies found in visual and mechanical inspections.
- \_\_2. Identify those parts of the LPS that don't pass the continuity test.
- \_\_3. Identify any resistance to earth of the earth-termination system as a whole or of each local earth electrode that exceeds 10 ohms.

## **SOW Item No. C27-03**

### **LV Building Grounding and Lightning Protection 5 Year PGM**

#### **PGM on Low Voltage Building Ground**

##### **Visual and Mechanical Inspections**

- \_\_1. Verify ground system in compliance with ANSI/NFPA 70, National Electrical Code, Article 250.
- \_\_2. Inspect physical and mechanical condition.
- \_\_3. Inspect anchorage.
- \_\_4. Replace mechanical type connectors with exothermic type.

##### **Electrical Tests**

- \_\_1. Perform resistance measurements through bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_2. Perform fall-of-potential or alternative test in accordance with IEEE Standard 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground should be 5 ohms or less. Investigate if resistance values exceed 5 ohms.
- \_\_3. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived points. Investigate point-to-point resistance values which exceed 0.5 ohms.

##### **Report**

- \_\_1. Identify deficiencies found in visual and mechanical inspections.
- \_\_2. Identify values of bolted electrical connections resistance measurement which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_3. Identify fall-of-potential values between the main grounding and ground which exceed 5 ohms.
- \_\_4. Identify point-to-point resistance values between the main grounding system grounding system and all major electrical equipment frames, system neutral, and/or derived points which exceed 0.5 ohms.

##### **Reference**

- \_\_1. ANSI/NFPA 70, National Electrical Code, Article 250
- \_\_2. IEEE Standard 81

## **PGM on Building Lightning Protection System (LPS)**

### **Visual and Mechanical Inspections to Ensure**

- \_\_1. The LPS is in good condition.
- \_\_2. There are no loose connections and no accidental breaks in the LPS conductors and joints.
- \_\_3. No part of the system has been weakened by corrosion, especially at ground level.
- \_\_4. All visually earth connections are intact.
- \_\_5. All visible conductors and system components are fastened to the mounting surfaces and components which provide mechanical protection, are intact and in the right place.
- \_\_6. There have not been any additions or alterations to the protected structure which would require additional protection.
- \_\_7. There has been no indication of damage to the LPS, surge protection devices, or any failures of fuses which protect the surge protection devices (SPDs).
- \_\_8. Bonding conductors and connections inside the structure are present and intact.

### **Electrical Tests**

- \_\_1. Perform continuity tests, especially continuity of those parts of the LPS which are not visible. Investigate those parts of the LPS that don't pass this test.
- \_\_2. Perform earth resistance tests of the earth-termination system. The resistance to earth each local earth electrode and where practical the resistance to earth of the complete earth-termination system. Each local earth electrode should be measured in isolation with the test joint between the down-conductor and earth electrode in the disconnected position. Investigate if the resistance to earth of the earth-termination system as a whole or of each local earth electrode exceeds 10 ohms.
- \_\_3. SPDs without a visual indicator need to be tested. Testing of SPDs should be in accordance with the manufacturer's published data.

### **Report**

- \_\_1. Identify deficiencies found in visual and mechanical inspections.
- \_\_2. Identify those parts of the LPS that don't pass the continuity test.
- \_\_3. Identify any resistance to earth of the earth-termination system as a whole or of each local earth electrode that exceeds 10 ohms.

**SOW Item No. C27-04**  
**LV Switchboard and Power Panel 5 Year PT&I**

**PT&I on Low Voltage Switchboard and Power Panel**

- \_\_1. Perform a thermographic survey.
- \_\_2. Provide a report which includes the following:
  - a. Description of equipment to be tested.
  - b. Discrepancies.
  - c. Temperature difference between the area of concern and the reference area.
  - d. Probable cause of temperature difference.
  - e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
  - f. Identify load conditions at time of inspection.
  - g. Provide photographs and thermograms of the deficient area.
  - h. Provide recommended action for repair.

**SOW Item No. C27-05**  
**LV Motor Control Center 5 Year PT&I**

**PT&I on Low Voltage Motor Control Center**

- \_\_1. Perform a thermographic survey.
- \_\_2. Provide a report which includes the following:
  - a. Description of equipment to be tested.
  - b. Discrepancies.
  - c. Temperature difference between the area of concern and the reference area.
  - d. Probable cause of temperature difference.
  - e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
  - f. Identify load conditions at time of inspection.
  - g. Provide photographs and thermograms of the deficient area.
  - h. Provide recommended action for repair.

**SOW Item No. C27-06**  
**LV Motor Control Center 5 Year PGM**

**PGM on Low Voltage Motor Control Center**

**Visual and Mechanical Inspections**

- \_\_1. Verify and record motor control center nameplate (voltage, phase, horizontal bus ampacity, equipment ID#, manufacturer, equipment model and type, and equipment year, etc...).
- \_\_2. Verify the motor control center in the field against the configuration control motor control center drawing and document discrepancies found.
- \_\_3. Inspect physical and mechanical condition.
- \_\_4. Inspect anchorage, alignment, and grounding.
- \_\_5. Clean the unit.
- \_\_6. Inspect arc chutes.
- \_\_7. Inspect moving and stationary contacts for condition, wear, and alignment.
- \_\_8. Check all indicating lamps, mechanical flags, doors and similar auxiliaries and repair. If required.
- \_\_9. Inspect all accessible electrical joints and terminals in the bus and wiring systems for sign of overheating or corrosion. Retighten bolts and nuts at bus joints if there is any sign of overheating or looseness.
- \_\_10. Check for the proper operation of all mechanical components.
- \_\_11. Operate the circuit breaker and switch to insure smooth operation. Verify that all circuit breaker contacts are open when the handle is in the OFF position and closed when the handle is in the ON position.
- \_\_12. Verify fuses and circuit breakers to make sure they are the proper ampere rating type and interruption rating.
- \_\_13. Use the proper lubrication recommended in the manufacturer's published data on moving current-carrying parts and on moving and sliding surfaces.

**Report**

- \_\_1. Identify discrepancies if motor control center nameplate is different from the motor control center data in MAXIMO.
- \_\_2. Identify discrepancies on configuration control motor control center drawings if drawings are different from field conditions.
- \_\_3. Identify deficiencies found in visual and mechanical inspections. Document changes, observations and repair made (if any).

**SOW Item No. C27-07**  
**LV Dry-Type Transformer 100KVA or Larger 5 Year PT&I**

**PT&I on Low Voltage Dry-Type Transformer**

- \_\_1. Perform a thermographic survey.
- \_\_2. Provide a report which includes the following:
  - a. Description of equipment to be tested.
  - b. Discrepancies.
  - c. Temperature difference between the area of concern and the reference area.
  - d. Probable cause of temperature difference.
  - e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
  - f. Identify load conditions at time of inspection.
  - g. Provide photographs and thermograms of the deficient area.
  - h. Provide recommended action for repair.

**SOW Item No. C27-08**  
**LV Dry-Type Transformer 100KVA or Larger 5 Year PGM**

**PGM on Low Voltage Dry-Type Transformer**

**Visual and Mechanical Inspections**

- \_\_\_1. Verify and record dry-type transformer nameplate (KVA, primary/secondary voltage, phase, transformer type i.e., delta to Y, isolation transformer and etc., Z value, and tap position if applicable, equipment ID#, manufacturer, equipment model & type, and equipment year).
- \_\_\_2. Inspect physical and mechanical condition.
- \_\_\_3. Inspect anchorage, alignment, and grounding.
- \_\_\_4. Clean the unit.
- \_\_\_5. Verify tap connections are as specified.

**Electrical Tests**

- \_\_\_1. Perform resistance measurements through bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_\_2. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.5 in the ANSI/NETA MTS. Investigate values of insulation resistance less than this table or manufacturer's recommendations. Calculate the dielectric absorption ratio or polarization index. Investigate dielectric absorption ratio or polarization index that is less than 1.0.
- \_\_\_3. Perform turn-ratio tests at the designated tap position. Investigate turn ratio test result that is deviate more than 0.5% from either the adjacent coils or from the transformer nameplate ratio.

**Report**

- \_\_\_1. Identify if transformer nameplate is different from transformer data in MAXIMO.
- \_\_\_2. Identify deficiencies found in visual and mechanical inspections.
- \_\_\_3. Identify values of bolted electrical connections resistance measurement which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_\_4. Identify values of insulation resistance which are less than Table 100.5 in the ANSI/NETA MTS or the manufacturer's recommendation. Compare dielectric absorption ratio or polarization index with previously obtained results and identify value that is less than 1.0.
- \_\_\_5. Identify turn ratio test result that is deviate more than 0.5% from either the adjacent coils or from the transformer nameplate ratio.

Reference: ANSI/NETA MTS Table 100.5

**SOW Item No. C27-09**  
**LV Automatic Transfer Switch Biennial PGM**

**PM on Low Voltage Automatic Transfer Switch**

**Visual and Mechanical Inspections**

- \_\_\_1. Verify and record automatic transfer switch nameplate, equipment ID #, manufacturer, equipment model and type, and equipment year.
- \_\_\_2. Inspect physical and mechanical condition.
- \_\_\_3. Inspect anchorage, alignment, grounding, and required clearance.
- \_\_\_4. Prior to cleaning the unit, perform as-found tests.
- \_\_\_5. Clean the unit.
- \_\_\_6. Use the proper lubrication recommended in the manufacturer's published data on moving current-carrying parts and on moving and sliding surfaces.
- \_\_\_7. Verify that manual transfer warnings are attached and visible.
- \_\_\_8. Verify tightness of all control connections.
- \_\_\_9. Perform manual transfer operation.
- \_\_\_10. Verify positive mechanical interlocking between normal and alternate sources.
- \_\_\_11. Perform as-left tests.

**Electrical Tests**

- \_\_\_1. Perform resistance measurements through bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_\_2. Perform a contact/pole-resistance test. Microhm or dc millivolt drop values should not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
- \_\_\_3. Verify settings and operation of control devices.
- \_\_\_4. Perform automatic transfer tests:
  - a. Simulate loss of normal power.
  - b. Return to normal power.
  - c. Simulate loss of emergency power.
  - d. Simulate all forms of single-phase conditions.
- \_\_\_5. Verify correct operation and timing of the following functions:
  - a. Normal source voltage-sensing and frequency sensing relays.
  - b. Engine start sequence.
  - c. Time delay upon transfer.
  - d. Alternate source voltage-sensing and frequency sensing relays.
  - e. Automatic transfer operation.
  - f. Interlocks and limit switch function.
  - g. Time delay and re-transfer upon normal power restoration.

## Report

- \_\_1. Identify deficiencies found in visual and mechanical inspections.
- \_\_2. Identify values of bolted electrical connections resistance measurement which deviate from those of similar bolted connections by more than 50% of the lowest value.
- \_\_3. Identify microhm or dc millivolt drop values of contact/pole-resistance which deviate from adjacent poles or similar breakers by more than 50% of the lowest value.
- \_\_4. Identify any control devices that are not operating in accordance with manufacturer's published data.
- \_\_5. Identify if automatic transfers are not operating in accordance with manufacturer's design.
- \_\_6. Identify if operation and timing are not in accordance with manufacturer's and/or system design requirements.

**SOW Item No. C27-10**  
**LV Automatic Transfer Switch Biennial PT&I**

**PT&I on Low Voltage Automatic Transfer Switch**

- \_\_1. Perform a thermographic survey.
- \_\_2. Provide a report which includes the following:
  - a. Description of equipment to be tested.
  - b. Discrepancies.
  - c. Temperature difference between the area of concern and the reference area.
  - d. Probable cause of temperature difference.
  - e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
  - f. Identify load conditions at time of inspection.
  - g. Provide photographs and thermograms of the deficient area.
  - h. Provide recommended action for repair.

**SOW Item No. C27-11**  
**LV Variable Frequency Drive Biennial PT&I**

**PT&I on Low Voltage Variable Frequency Drive**

- \_\_1. Perform a thermographic survey.
- \_\_2. Provide a report which includes the following:
  - a. Description of equipment to be tested.
  - b. Discrepancies.
  - c. Temperature difference between the area of concern and the reference area.
  - d. Probable cause of temperature difference.
  - e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
  - f. Identify load conditions at time of inspection.
  - g. Provide photographs and thermograms of the deficient area.
  - h. Provide recommended action for repair.

**SOW Item No. C27-12**  
**LV Variable Frequency Drive Biennial PGM**

**PM on Variable Frequency Drive**

**Visual Inspection and Measurements**

NOTE: Proper notification that the system will be down (EMCS & HVAC)

- ☐ 1. Verify and record variable frequency drive nameplate, equipment ID#, manufacturer, equipment model and type, and equipment year.
- ☐ 2. Visually inspect before shutting down, note the rotation.
- ☐ 3. Check cabinet that all power is off and tagged.
- ☐ 4. Check capacitors and dc bus that residual power is bleed off.
- ☐ 5. Clean inside cabinet.
- ☐ 6. Check all fans for any binding.
- ☐ 7. Check pc boards are seated.
- ☐ 8. Check and inspect that wire connection are tight.
- ☐ 9. Inspect for signs of overheating components or connections.
- ☐ 10. Inspect capacitors for leakage, bulging, or discoloration.
- ☐ 11. Measure resistance of scr's for proper resistance.
- ☐ 12. Assemble drive back together.
- ☐ 13. Remove all tags and re-energize.
- ☐ 14. Verify rotation.
- ☐ 15. Place drive back in operation.
- ☐ 16. Measure drive current, frequency and voltages.
- ☐ 17. Check and record heat sink temperatures.

**Report**

- ☐ 1. Identify deficiencies found in the above visual inspections, and measurements.
- ☐ 2. Record all measurements.

**SOW Item No. C27-13**  
**Institutional Generators Semi-Annual PM**

- ☐ 1. Test generator and transfer switches under load for at least 30 minutes.
- ☐ 2. Record all available instrument readings and run time.
- ☐ 3. Check the following systems as indicated:

**Diesel fuel systems**

- ☐ 1. Drain water from fuel filters (if applicable).
- ☐ 2. Drain water from day tank (if applicable).
- ☐ 3. Check fuel gauges and drain water from main fuel tanks.
- ☐ 4. Inspect all main fuel tank vents.
- ☐ 5. Main fuel level.
- ☐ 6. Day tank fuel level.
- ☐ 7. Operation of fuel supply pump and controls.

**Engine cooling systems**

- ☐ 1. Coolant level.
- ☐ 2. Rust inhibitor in coolant.
- ☐ 3. Antifreeze in coolant.
- ☐ 4. Adequate fresh air to engine and radiators.
- ☐ 5. Condition of fan and alternator belts. Replace if necessary.
- ☐ 6. Squeeze and check condition of hoses, ductwork and connections. Replace as necessary.
- ☐ 7. Functioning of coolant heater.

**Engine lubricating system**

- ☐ 1. Oil level.
- ☐ 2. Crankcase breather not restricted.
- ☐ 3. Appearance of lubricating oil.
- ☐ 4. Oil pressure.

**Engine electrical starting system**

- ☐ 1. Check battery electrolyte specific gravity.
- ☐ 2. Check battery cap vents.
- ☐ 3. Battery terminals clean and tight.
- ☐ 4. Add distilled water to maintain proper electrolyte level.
- ☐ 5. Battery charging rate.
- ☐ 6. Battery trickle charging circuit operating properly.
- ☐ 7. No exhaust leaks.
- ☐ 8. Exhaust not restricted.
- ☐ 9. All connections tight.

**Transfer switches**

- ☐ 1. Inside clean of foreign matter.
- ☐ 2. No unusual sounds.

- \_\_3. Terminals and connectors normal color.
- \_\_4. Condition of all wiring insulation.
- \_\_5. All covers tight.
- \_\_6. Doors securely tight.
- \_\_7. Check messages on the pss system and make corrections if needed.
- \_\_8. Fill out maintenance record/report.

**SOW Item No. C27-14**  
**Institutional Generators Annual PM**

**Engine cooling systems**

- ☐ 1. Clean exterior of all radiators.
- ☐ 2. Check engine water and circulating pumps.
- ☐ 3. Change coolant.

**Engine lubricating system**

- ☐ 1. Change oil.
- ☐ 2. Change oil filter (if sufficient hours).
- ☐ 3. Clean crankcase breather.

**Governor**

- ☐ 1. Check all linkages and ball joints.
- ☐ 2. Check oil level (if applicable).
- ☐ 3. Observe for unusual oil leakage.

**Engine exhaust system**

- ☐ 1. Check condition of mufflers, exhaust lines, supports and connections.

**Fuel system**

- ☐ 1. Analyze fuel for condition (replace if necessary).
- ☐ 2. Change fuel filter.
- ☐ 3. Change or clean air filter.

**Generator**

- ☐ 1. Clean generator windings.
- ☐ 2. Check generator bearings.
- ☐ 3. Measure and record resistance readings of generator windings using megger.
- ☐ 4. Check brush length and pressure.
- ☐ 5. Check appearance of slip rings; clean if necessary.
- ☐ 6. Blow out with clean, dry compressed air.

**Transfer switches**

- ☐ 1. Inspect main switchgear and generator switchgear. Repair/replace as necessary.
- ☐ 2. Operate each circuit breaker manually.
- ☐ 3. Visually check bus bars, bracing and feeder connections for cleanliness and signs of overheating.

**Engine safety controls**

- ☐ 1. Clean all engine controls and check appearance of all components.
- ☐ 2. Check meters.

- \_\_3. Check operation of all engine-operating alarms and safety shutdown devices.

### **System controls**

- \_\_1. Reevaluate the settings of the voltage sensing and time delay relays.

### **Generator switchgear**

- \_\_1. Determine whether changes to the electrical supply system have been made that require a revision of main circuit breaker, fuse, or current-limiting bus duct coordination.
- \_\_2. Calibrate and load test main circuit breakers.
- \_\_3. Spot check bus bar bolts and supports for tightness.
- \_\_4. Obtain and record insulation tester readings on bus bars and circuit breakers.
- \_\_5. Obtain and record insulation tester readings on internal distribution feeders.

### **Connected load**

- \_\_1. Check for potential overload.
- \_\_2. Check messages on pss system, correct as necessary.
- \_\_3. Fill out maintenance record/report

**SOW Item No. C27-15**  
**Portable Generator Semiannual PM**

- \_\_1. Check with area personnel for any obvious deficiencies.
- \_\_2. Check engine oil level, add as required.
- \_\_3. Change engine oil and air filter.
- \_\_4. Check battery charge and electrolyte specific gravity; add water as required; check terminal for corrosion; service or replace as required.
- \_\_5. Check belt tension and wear; adjust as required, if applicable.
- \_\_6. Check that crankcase heater is operating.
- \_\_7. Check engine oil filter, change as required.
- \_\_8. Check wiring connections, switches, etc., adjust as required.
- \_\_9. Perform 30 minute generator test run; check for proper operation. Record run time.
- \_\_10. Wipe dust and grease from engine and generator.
- \_\_11. Check fuel level; add as required.
- \_\_12. Fill out maintenance report.

**SOW Item No. C27-16**  
**Portable Generator Annual PM**

- \_\_1. Check with area personnel for any obvious deficiencies.
- \_\_2. Check engine oil level, add as required.
- \_\_3. Change engine oil and air filter.
- \_\_4. Check battery charge and electrolyte specific gravity; add water as required; check terminal for corrosion; service or replace as required.
- \_\_5. Check belt tension and wear; adjust as required, if applicable.
- \_\_6. Check that crankcase heater is operating.
- \_\_7. Check engine oil filter, change as required.
- \_\_8. Check wiring connections, switches, etc., adjust as required.
- \_\_9. Wipe dust and grease from engine and generator.
- \_\_10. Check fuel level; add as required.
- \_\_11. Check spark plug or injector nozzle condition; service or replace as required.
- \_\_12. Perform full load test.
- \_\_13. Fill out maintenance report/record.

**SOW Item No. C27-17**  
**Institutional UPS/Battery Semi-annual PM**

**Liquid type cell checks:**

- ☐ 1. Battery appearance and cleanliness.
- ☐ 2. Cell float voltage and specific gravity.
- ☐ 3. Charger output voltage and current.
- ☐ 4. Electrolyte levels.
- ☐ 5. Cracks in cells or any evidence of electrolyte leakage.
- ☐ 6. Evidence of corrosion at terminals or connectors.
- ☐ 7. Ambient temperature and condition of ventilation equipment.

**Maintenance free cell checks:**

- ☐ 1. Battery appearance and cleanliness.
- ☐ 2. Float voltage.
- ☐ 3. Charger output current and voltage.
- ☐ 4. Cracks in batteries.
- ☐ 5. Evidence of corrosion at terminals or connections.
- ☐ 6. Fill out maintenance report/record.

**SOW Item No. C27-18**  
**Institutional UPS/Battery Annual PM**

**Follow manufacturer's procedure.**

- \_\_\_1. UPS initial checks- system energized and feeding customer load. Verify initial, as found voltage and current of the following:
  - a. Rectifier input
  - b. Rectifier output
  - c. Inverter output
  - d. Alternate feed
  
- \_\_\_2. System in bypass and de-energized - customer load on alternate feed. Verify the following:
  - a. Bolted, screw and crimp connections for tightness
  - b. Relays seated properly
  - c. Wiring, for electrical and physical damage
  - d. Capacitors, for bulging or leaking
  - e. Proper alignment of all sliding pc boards
  - f. Plugs, for proper electrical and physical connection
  - g. PC boards, for overheating
  
- \_\_\_3. System in bypass and energized - customer load on alternate line. Verify the following:
  - a. All alarms for proper function and operation
  - b. Measure and adjust all critical logic settings
  
- \_\_\_4. Final check - system energized and carrying customer load.
- \_\_\_5. The following checks are performed on the battery:
- \_\_\_6. For liquid type cells perform the following checks:
  - a. Visual inspection of the condition of each cell.
  - b. Tightness of bolted connections to the recommended torque value.
  - c. Complete cell-to-cell and terminal connections resistance measurement.
  - d. Integrity of battery rack.
  - e. Specific gravity check.
  - f. Watering: electrolyte is leveled in each cell, maintained between high and low marks.
  - g. Ambient temperature and condition of ventilation equipment.
  - h. Evidence of corrosion at terminals or connectors
  
- \_\_\_7. Maintenance free cell checks:
  - i. Make visual inspection of the condition of each cell.
  - j. Check tightness of bolted connections to the recommended torque value.
  - k. Complete cell-to-cell and terminal connections resistance measurement.
  - l. Check integrity of battery rack.
  - m. Check for evidence of corrosion at terminals or connectors.
  
- \_\_\_8. Fill out maintenance report/record.

**SOW Item No. C2-19**  
**Institutional UPS/Battery Annual PT&I**

- \_\_1. Perform infra-red thermography inspection.
- \_\_2. Record results as required.
- \_\_3. Initiate repair actions as required.
- \_\_4. Fill out maintenance report/record